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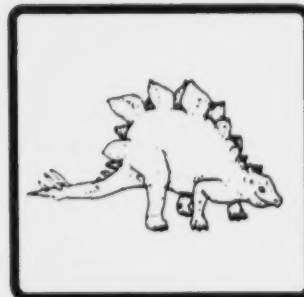
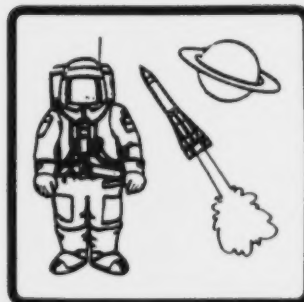
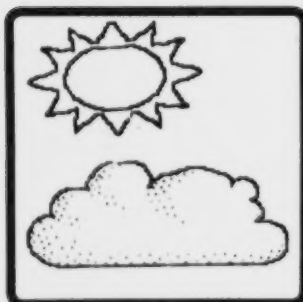
ABSTRACT

It is often claimed that students must have a thorough understanding of the processes of science to understand the constant changes in scientific theories and make meaningful decisions. This curriculum guide has five major parts including goals and objectives of elementary school science, problem solving, suggested scope and sequence, instructional aids and resources. Also included is a section on curriculum considerations for handicapped students. The section on instructional aids includes information on: (1) how to prepare; (2) safety; (3) equipment; (4) field trips; (5) science fairs, projects, clubs; (6) inservice training for science teachers; (7) science career education; and (8) computers in science education. Resource listings include periodicals, catalogs, regional resources, North Dakota publications, maps, science in the kitchen, and books for science experiments. (CW)

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ELEMENTARY SCIENCE CURRICULUM GUIDE

K-6



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Dr. Wayne G. Sanstead, SUPERINTENDENT
North Dakota Department of Public Instruction
Bismarck, North Dakota 58505

April, 1988

**NORTH DAKOTA
ELEMENTARY SCIENCE CURRICULUM GUIDE**

K-6



Dr. Wayne G. Sanstead, SUPERINTENDENT
North Dakota Department of Public Instruction
Bismarck, North Dakota 58505

April, 1988

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FOREWORD

Science is a unique curricular area. The foundations of science are changing constantly as new scientific theories are tested and past phenomenon are understood. With the knowledge of science doubling every ten years, students cannot function effectively in today's society if all they know are some "facts" of science. Rather, they must have a thorough understanding of the process of science to understand these changes and make meaningful decisions. Therefore, educators must teach their students to understand how science is organized and why science changes.

Science has been taught for too long as a subject to be memorized and only thoroughly enjoyed by those students with a gift to relate rote facts with the world around them, or lucky enough to have had "just the right teacher." Experimentation and "taking chances" should be encouraged. Science should be taught using all of the senses. Science should be touched, heard, built, dismantled, broken, stacked, pulled, and pushed.

Science should be nonthreatening to the teacher. Various professional organizations, state agencies, and private businesses provide many opportunities for inservice training in various areas of science as well as providing curricular materials and resource persons. These opportunities must be utilized by both teachers and administrators to enhance the science program.

The elementary teacher has too many areas of responsibilities to be able to stay abreast of them all. Each school should have at least one teacher assigned to a speciality area such as math, science, or reading. Their responsibility is to focus on materials, trainings, etc., available in that area and then gather and disseminate that information to the rest of the staff. Only by this sharing can useful information and training opportunities be effectively communicated to teachers.

Dr. Wayne G. Sanstead
Superintendent

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The North Dakota Elementary Science Curriculum Guide was written by a group of educators representing the various geographic regions of the state as well as different school sizes and grade levels. Their time and effort in compiling this document is greatly appreciated.

Elementary Science Curriculum Committee

Dr. Elmer Schmiess
Associate Professor
University of North Dakota

Mr. Jan Beauchman
Washington Elementary School
Valley City

Vivian Meiers
Grimsrud Elementary School
Bismarck

Mrs. LaVina Bosch
St. Joseph's Elementary School
Devils Lake

Mr. Duane Koble
Little Flower Elementary School
Rugby

Mary Debertin
St. Leo's Elementary School
Minot

Tom Lautenschlager
Erik Ramstad Junior High School
Minot

Mr. Norm Zielinski
Roosevelt Elementary School
Dickinson

Mrs. Kathy Stahl
Davenport Elementary School
Kindred

Mr. Scott Matheson
Eastwood Elementary School
West Fargo

Ron Messelt
Longfellow Elementary School
Fargo

Mike Burton
Agassiz Junior High School
Fargo

Walter Darr
Williston Junior High School

Mrs. H. Janet Markwart
Beulah Elementary School

Minnie Flynn
Dunseith Day Elementary School

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Dr. Wayne G. Sanstead, Superintendent
Mr. Ron Stastney, Assistant Superintendent, Instruction
Judy Ortlip, Coordinator, Information Processing
Pam Wolf, Information Processing
Paula Gabel, Secretary
North Dakota Curriculum Council

Charles DeRemer
Director of Curriculum

INTRODUCTION

The Elementary Science Curriculum Guide is organized to give both the teacher and administrator guidance in organizing their elementary science curriculum. The guide has five major parts. The first section deals with the goals and objectives of elementary school science. Section two addresses problem solving. These two sections express the fundamental emphasis of the guide--increasing students' problem solving abilities and increasing their appreciation of the world around them.

The third section presents a suggested scope and sequence. This section was developed by careful analysis of current literature and correlation with commonly used texts in our state. This section should provide clear direction for teachers and administrators in planning a sequential elementary science curriculum and provide students with a good foundation for future science courses.

A section on instructional aids will help the teacher in planning science lessons. This section was written to provide the teacher with a quick, concise reference to questions often asked by teachers. The authors hope that this section will make the teacher more comfortable "doing science" in the classroom.

The final section provides a partial list of resources available to supplement text material. Since the writing committee firmly believes that the commercial text should be only a portion of the science curriculum, a list of other resources was developed. The committee hopes that schools will greatly utilize this supplementary material.

CURRICULUM CONSIDERATIONS FOR THE HANDICAPPED AND SLOW LEARNER

During the last decade, significant legislation has been passed concerning the needs of handicapped students and the responsibility of public schools to address those needs. In summary, federal regulations state that the local school district must provide an appropriate educational program in the least restrictive environment for all identified handicapped students. The slow learner, although not under the federal mandate, may also require similar considerations in programming. In response to the above needs it is necessary to develop guidelines to meet the needs of the target population by providing assistance to regular and special educators.

The area of science is of special concern to regular and special educators. Not only is it a major tool area, but is also an area where the handicapped learner is frequently mainstreamed. The provision of an appropriate education program for the handicapped learner should provide a challenging science program at the student's ability level. Program planners will need to give special consideration to the relevancy of science curriculum as it relates to each student's unique needs.

Federal and state regulations require that all school districts identify handicapped students. This process may also identify other students who require special considerations. A building level team approach is one method of identifying and providing for those students who do not categorically qualify for an area of special education. Team membership could include building administrator, regular and special educators, parents, students, and individuals from other agencies.

Students identified as handicapped require individualized education programs. The construction of the IEP is a team approach. This team is responsible for determining whether a student is able to participate in regular science classes without modifications, in regular science classes with modifications or if an alternative program needs to be developed. Building level teams may follow similar procedures with nonhandicapped students.

If the team decision is to enroll the student in the regular classroom with modifications, these modifications will be limited only by the creativity of the team members. Some examples might include: 1) altering time and quantity requirements, 2) use of learning packets, 3) use of audiovisual aids, 4) computer assisted instruction, 5) test-taking options, 6) alternate materials such as texts, 7) peer tutoring, 8) team teaching, 9) contracting, 10) selecting the most relevant science objectives, etc. Teachers making these modifications may want to consult with building administrator and special education personnel to explore grading options.

Should the team decide that the student would be unable to function in the regular classroom with modifications, an alternative program will be developed by the team. Those developing alternative programs may wish to refer to scope and sequence references such as district curriculum guides, commercial scope and sequence charts, and North Dakota Department of Public Instruction Science Curriculum Guide K-6 (1988). Although a team approach may be used, the primary responsibility for instruction of mainstreamed science students lies with the classroom teacher.

The following persons were involved in writing this section for special needs students. Their assistance is appreciated.

James Stenehjem, Principal
Watford City High School

Wayne Triska, Vision Impaired
Bismarck Public Schools

Twila Jarrett, EMH Teacher
Bismarck Public Schools

Joan Bonsness, LD Teacher
Central Campus High School, Minot

Kathryn Plowman, LD Teacher
Oliver/Mercer Special Education Unit, Center

Neil Pederson, Math Teacher
Carrington High School

Betty Vibeto, Program Coordinator
Souris Valley Special Education Unit, Minot

Linda Hartman, LD Teacher
Central High School, Grand Forks

Connie Hovendick, ED Teacher
Lake Region Special Education Unit, Devils Lake

Chris Strom, Program Coordinator
Lake Region Special Education Unit, Devils Lake

Donald Boehmer, Director
Lake Region Special Education Unit, Devils Lake

Judi Bryl, Business Manager
Lake Region Special Education Unit, Devils Lake

**GOALS AND OBJECTIVES
OF ELEMENTARY SCHOOL SCIENCE**

GOALS AND OBJECTIVES

A major responsibility of education is to produce citizens capable of making informed decisions about today's complex technological and scientific society. The following set of goals and objectives will help nurture and reinforce a child's open-mindedness and curiosity about the world and create a foundation for effective problem solving.

The objectives to these goals are not meant to be all inclusive but merely representative samples.

GOAL I

To encourage systematic and organized thinking through problem solving.

OBJECTIVES

The student should be able to:

1. Define the problem and state the question.
2. Collect data through observation and other methods.
3. Make predictions based on these observations.
4. Conduct the appropriate experiments to verify the predictions.
5. Write a conclusive report based on experimentation.

GOAL II

To encourage open-minded and positive attitudes toward science and its impact on society and the student.

OBJECTIVES

The students should be able to:

1. Display curiosity about the world around them.
2. Discriminate the difference between myths/superstitions and scientific findings.
3. State science contributions by men and women of various ethnic and cultural groups to science.
4. Describe the consequences of science and technology on society.

GOAL III

To relate other subject areas to the science program.

OBJECTIVES

The student should be able to:

1. Apply computational and measurement skills in problem solving.
2. Use oral and writing skills in problem solving.
3. Use problem solving skills as applied to social problems.
4. Use reading as a means of gathering science information.

GOAL IV

To understand the natural world by using knowledge obtained through investigation, study, and instruction of science.

OBJECTIVES

The students should be able to:

1. Identify the basic necessities of living things.
2. Discriminate between plants and animals.
3. Describe matter and energy using appropriate language.
4. Describe the erosional effects on soil and land forms.
5. Understand the natural environment of North Dakota.

GOAL V

To enable a student to apply science skills to everyday experiences.

OBJECTIVES

The student should be able to:

1. Identify science related careers and recreational activities.
2. Relate present science experience to career requirements.
3. Predict possible trends in science and technology.
4. Identify and label natural processes and products.

PROBLEM SOLVING SKILLS

PROBLEM SOLVING SKILLS

The first scientist was the first person who ever asked "why" wondered about something and set out logically to discover an answer. Inquiry is the very foundation of science. Scientists do not find their thinking processes different in curiosity level. The scientists would like to think they have the same inordinate level of curiosity as children. It is this curiosity level that causes children to find many experiences stimulating and any stimuli that will get the student to say;

"Hmm, that's neat!
I wonder?"
That is science!

1. Questioning:

Questioning can and should be a major factor of the teachers' planning for their student's progress in the classroom. The wise use of questions will enhance the presentation of most objectives.

No problem-solving process can operate unless some question has first been posed. The only restriction to the questioning is that each problem must be specific and limited. "I wonder about the world?" will lead to no conclusion until it is rephrased and limited to "I wonder how big the world is?" or "what is the shape of the world?" Throughout the lesson questions will arise from the children. The teachers need not provide answers to these questions; rather they should encourage additional investigative techniques that may support discoveries or challenge the students to pursue further investigation or to arrive at a final conclusion.

Questions may be classified into two categories; open-ended and close-ended questions. Open-ended (divergent) questions foster inquiry by the students to investigate the topic further. All of these questions require thinking skills. Other questions can be classified as close-ended. Close-ended questions (convergent) tend to cause children to summarize and draw conclusions. Close-ended questions may be helpful in beginning the grouping or regrouping of experiences which may lead to generalizations and understandings.

Open-Ended Question Examples:

- a. What are the differences between western and eastern North Dakota?
- b. How has the Garrison Dam changed North Dakota?

Close-Ended Question Examples:

- a. What is the state bird of North Dakota?
- b. Name a type of animal that has a two chambered heart.

The questions that have been discussed by the class can facilitate good problems for investigations. It is important that the problems have high student interest and are considered worthwhile investigating.

2. Observation:

Observation is a basic skill in the process of collecting data that uses sight, smell, touch, taste, or hearing. The initial observation should focus upon those questions raised by the students or upon the framework provided by the teacher. These observations will probably be very broad in scope and will stimulate additional questions. The whole process may begin with the question, "What do you observe?" For acceptable scientific observation, one must observe from every possible vantage point and evaluate all findings. The whole process may be more meaningful and exact if the student records each observation as it is made. The record must describe rather than explain that which is observed. The tabulation should be brief with descriptive phrases, quantities, or clarifying sketches. Often a simple listing and not a narrative is adequate. Students should be encouraged to cross out words or statements, not to erase them. This will help to instill the idea that making and correcting mistakes is acceptable.

When possible, students should expand their observations through library research or personal interviews to compare or confirm what they have observed or discovered. During this comparison the observer should record the information that is relevant to the primary question. Observation should be left open to experimentation and may lead to further questions and conclusions.

3. Experimentation (Investigation):

Experimenting is the spirit of active inquiry into questions raised by children about their surroundings. It is intended to be a manipulation of equipment to find the answer for their questions. It is the "hands-on" part of science and starts by defining the problem.

a. Defining the Problem

The natural curiosity of the students should lead to the definition of a problem. The teachers role in this process should be one of encouraging and stimulating students questioning to determine further the exact nature of the problem. This is accomplished by asking probing questions that will determine what the students want to find out. The next step is to have them predict what they think is the answer. It is this tentative conclusion that will define the problem. In addition, the teacher and students will continue to ask questions throughout the investigation.

b. Collecting Data

Once the problem has been defined, the students' curiosity will lead them to the next problem-solving process of collecting data. This may be done in a number of ways, including observation, experimentation and measurement.

c. Analyzing the Data

It is usually desirable to have descriptive observations expressed in units. This allows the experimenter to look for mathematical relationships (formulas) or observations that are incompatible with the conclusion. Does all the data agree with the conclusion?

d. Conclusion

The conclusion is based solely on the analysis of data and is accepted for the time. Additional conflicting observations may require modified conclusions and in this sense all conclusions are temporary.

4. Suggested Guidelines:

The following ideas should be kept in mind when conducting hands-on experiments in the elementary classroom:

- a. Every experiment should be selected and performed in a manner which will help children think.
- b. Make certain the children are aware of the purpose of the experiment.
- c. All experiments should be a hands-on experience for the child.
- d. Students should be encouraged to devise original experiments in an attempt to discover answers to questions that may have occurred to them. With the guidance of the teacher, pupil-designed experiments provide the opportunity for children to understand the need for careful planning, careful observation, critical thinking, following directions, and proper method.
- e. Experiments should be performed carefully and in accordance with simple directions understood by all children.
- f. Students should be aware of the importance of critically observing and accurately recording all the events during the experiment so that they may obtain reliable results. It is recommended that students learn to record their collected information in a table or chart.
- g. Students should be led to understand that generalizations should not be made from a single experiment. They should be aware that frequently an experiment must be performed more than once, and that scientists actually repeat experiments many times to obtain accurate and valid conclusions.
- h. At the elementary level, experiments should be kept simple. The simplest materials are most desirable.

It might also be noted that no experiment is ever a failure. The statement, "I tried the experiment, but it didn't work," implies a predetermined conclusion which is contrary to the method of science. If an activity "does not come out right," a real challenge has been presented; namely, what is the reason for the unexpected observation? A demonstration may fail, but an experiment cannot fail.

**SCOPE AND SEQUENCE
OF ELEMENTARY SCIENCE CURRICULUM**

KINDERGARTEN

PLANTS

Collect and observe different types of plants

Collect and compare different types of seeds

Determine the needs of plants

Grow a plant from seed

ANIMALS

Observe different types of animals

Compare young animals with their parents

Determine the needs of animals

Compare the locomotion movements of animals

Investigate the body coverings of animals

Observe the plants and animals in an aquarium

EARTH

Investigate rocks

Describe the size, shape, color, texture, and kinds of rocks

Compare the texture and color of soil types

Discuss the earth's source of light and heat

ECOLOGY

Describe environment

Discuss living and nonliving things

Observe woods, prairie, bog, and pond habitats

Compare the interaction of plants and animals living on land and in water
(Ecology: the branch of biology that deals with the relations between living organisms and their environment)

HEALTH

Identify the body parts

Discuss feelings and how they are important to good health

Explain why we need proper amounts of sleep and exercise
Demonstrate the proper grooming and hygiene for hair and teeth
Discuss sources of food
Use the sense of touch in comparing, grouping, and identifying things
Collect and discuss pictures of safety practices

MATTER

Identify and name the basic colors
Observe, compare, and describe the basic shapes
Distinguish and describe the difference between more and less, big and small, and thick and thin
Sort objects by weight, length, and height

ENERGY

Listen and distinguish between pleasant and unpleasant sounds
Observe the production of sound by vibrating objects
Identify sounds that may be harmful
Discover that sound travels in all directions
Investigate the use of sound as a warning signal

WEATHER

Identify the four seasons
Describe daily weather according to feelings: good, nice, cold, hot, etc.
Discuss the different types of weather
Discuss the concept of air and how it can be experienced

SPACE

Introduce the planets
Compare the sun and moon: size, shape, etc.
Explain night and day
Discuss rockets and astronauts

GRADE 1

PLANTS

- Observe the different colors, shapes, and sizes of plants
- Observe and name the roots, stems, leaves, and reproductive parts of plants
- Investigate the needs of plants
- Investigate ways of starting plants from bulbs, seeds, cuttings, etc.
- Observe places where plants grow
- List uses of plants
- Investigate how plants move to new locations

ANIMALS

- Discuss how animals are born
- Investigate how and where animals live
- Observe the size, shapes, colors, and body coverings
- Investigate how animals move to new locations
- Investigate the uses of animals

EARTH

- Describe and illustrate the shape of the Earth
- Describe the composition of the Earth
- Investigate the parts of soil
- Observe air directly with the sense of touch and indirectly with the sense of smell, sight, and hearing
- Demonstrate that air takes up space
- Demonstrate that air can support objects
- Collect pictures of the uses of water and air

ECOLOGY

- Observe the environment of plants and animals in your area
- Investigate what your senses can tell you about the environment

Describe the interdependence of plants and animals

Describe why living things need a healthy environment

Identify the causes and effects of pollution in your area

HEALTH

Identify and list foods that are nutritious

Describe the necessity of food for good health and growth

Discuss why rest, exercise, proper dress, and hygiene are necessary for good health

Discuss the importance of proper dental hygiene

List and explain safety rules

MATTER

Classify the characteristics of living and nonliving things

Identify, compare, and classify: colors, shapes, and sizes

Predict color results when two primary colors are combined

Compare the concepts of transparent, translucent, and opaque things

ENERGY

Observe movement

List different ways things move

List ways people cause things to move

Investigate machines and describe how they move things

Distinguish between direct and reflected light

WEATHER

Describe daily weather with the use of a thermometer, along with adjectives or feelings

Discuss the four seasons and how they affect our dress and activities

Demonstrate that water is the result of melted snow

Demonstrate that air can cause movement

SPACE

Observe the light and heat from the sun

Discuss the harmful effects of the sun and ways to protect yourself

Identify ways people, animals, and plants depend on the sun

Introduce the stars and moon in the night sky

Introduce the concepts of stars and forming constellations

Collect pictures of people traveling in space

GRADE 2

PLANTS

Observe plants in reference to roots, stems, leaves, flowers, and seeds

Observe and collect plants demonstrating seasonal changes

Determine the characteristics of plants

Observe the production of seeds from flowers

Identify the parts of a seed

Investigate plants as a source of food

ANIMALS

Investigate and determine the characteristics of six major groups of animals: birds, mammals, reptiles, amphibians, fish, and invertebrates

Identify ways that animals may help or harm humans

Observe how seasonal changes affect the appearances and behaviors of animals

Collect drawings, pictures, and observe common animals in your area

EARTH

Discuss the concept of the Earth as a planet

Discuss the concept of earth as soil and rocks

Demonstrate the water cycle

List the uses and effects of salt and fresh water

Investigate the causes and preventions of pollution

ECOLOGY

Investigate a variety of habitats such as: deserts, prairies, and ponds

Observe and describe interdependence of plants and animals with their environment

Compare the types of plants and animals living in differing habitats

Identify endangered and extinct plants and animals

HEALTH

Introduce and investigate the five senses

Identify similarities and differences in physical characteristics and growth

Identify the basic four food groups and classify foods into the groups

List proper preparation and storage of food

Identify and explain the importance of safety to good health

MATTER

Identify different kinds of matter as living or nonliving

Classify matter as solid, liquid, or gas

Discover the volume, shape, weight, and density of an object

Differentiate between man-made and natural objects

ENERGY

Investigate the sources, uses, and dangers of heat and light

Demonstrate different ways of reflecting light

Investigate kinds and shapes of magnets

Observe and list applications of magnets

Investigate sound production, transmission and reception

WEATHER

Describe daily weather with the use of a thermometer, barometer, and rain gauge, along with adjectives or feelings

Discuss why we have seasons

Study the seasonal changes and how they affect living things

Observe air using the sense of touch, smell, sight, and hearing

Describe how wind is air in motion

SPACE

Define stars

Compare the size, brightness, and distance of stars

Observe star patterns and identify some common constellations

Introduce the nine planets in the solar system

Consider the purpose of space travel

Learn about some of the famous astronauts

GRADE 3

PLANTS

Explain the importance of plants

Investigate how plants store their food in roots, stems, leaves, and reproductive parts

Describe a variety of plants and where they are commonly found

Describe how plants depend on other living things for their well-being

ANIMALS

Discuss why animals are important

Identify a variety of animals and where they are commonly found

Discuss how animals have special adaptations which protect them from their enemies

Explain why animals migrate

Discuss the stages of life cycles of certain animals

Compare and contrast egg-laying animals and live-bearing animals

EARTH

Describe how the surface of the Earth is constantly changing

Study the composition of the Earth's crust, and its uses and abuses

Discuss how the Earth is changed by living things, water, and wind

Discuss the concept of erosion, and how it is largely responsible for the wearing down process of soil

ECOLOGY

Describe why plants and animals are important in our environment

Describe ways to protect and preserve endangered animals

Discuss how animals use the food cycle

HEALTH

Discuss the importance of a balanced diet

Compare and contrast good and poor eating habits

Investigate the way the body uses different foods to make energy and to grow

Identify various bones and muscles

Describe why exercise and sleep are essential to life

Discuss the importance of safety habits

MATTER

Discuss the properties of matter, such as volume, shape, weight, and density

Describe physical and chemical changes in matter

Explore the three states of matter: solids, liquids and gases

ENERGY

Introduce force as a push or pull

Discuss kinds of forces: gravity, magnetism, and friction

Describe work as movement due to force

Describe energy as the ability to do work

Identify the sources of energy

Describe the uses of machines

Identify and describe the functions of a lever, inclined plane, wheel and axle, pulley, and a wedge

WEATHER

Describe daily weather with the use of a thermometer, barometer, hygrometer, and weather vane by being more specific and using fewer adjectives

List reasons for temperature change from season to season

Discuss the concepts of the water cycle

Discuss air as a substance

Discuss uses and dangers of wind and rain

SPACE

Discuss rotation and revolution

Discuss how the sun is the center of our solar system

Introduce our galaxy, the Milky Way

Explain causes of night and day

Discuss the phases of the moon

Study the history of space travel

GRADE 4

PLANTS

- Observe how seedless plants are different from each other
- Distinguish between one seed leaves (monocotyledons) and two seed leaves (dicotyledons)
- Distinguish between conifers and deciduous trees
- Determine the role of light in the growth of green plants
- Investigate the substances in soil
- Investigate molds

ANIMALS

- Discuss the food chain
- Observe the life cycle of a frog
- Observe the life cycle of an insect
- Explain how insect pests are controlled
- Identify the survival requirements for fish
- Identify and describe protective body features

EARTH

- Identify melted rock (igneous), rocks from sediment (sedimentary), and rocks that change into other rocks (metamorphic)
- Investigate minerals and their value
- Discuss the formation of fossils and fossil fuels
- Compare and describe chemical and physical weathering
- Discuss the geologist and his work

ECOLOGY

- Introduce interdependence as part of an environment
- Describe the elements of a pond water environment
- Construct a "web of life"
- Observe environments in nature and construct terrariums

Investigate microscopic objects

Describe the effects of different types of pollution on your environment

HEALTH

Describe the components of bones

Identify different kinds of joints and demonstrate their functions

Describe how nerves cause muscle movement

List examples of voluntary and involuntary muscles

Introduce the body systems

Explain digestion as the process of breaking down food

Discuss the effect of activity and emotion on digestion

MATTER

Identify the properties common to all matter

Describe the effect gravity has on matter

Discuss the relationship between atoms and molecules

Describe how temperature relates to the speed of molecules and potential changes in matter

ENERGY

Identify heat as a form of energy

Identify some uses of steam

Identify good and poor heat conductors

Describe how coal, oil, petroleum, and natural gas are formed

Investigate the discovery and production of fossil fuels

Investigate forces that cause things to move

Demonstrate friction

Identify some uses of friction

Describe the effects of friction on matter

Identify simple and compound machines

Describe how machines make work easier

WEATHER

Describe the instruments used to measure air temperature, air pressure, wind speed, and moisture in the air

Describe daily weather with the use of a thermometer, barometer, hygrometer, and anemometer

Explain the effects of weather conditions on our daily lives

Identify global weather and its variations

Observe and describe the water cycle

Observe the effects of precipitation, condensation, freezing, and evaporation on weather

SPACE

Compare the sizes of planets and discuss their positions and orbits

Describe the source of light for the nine planets

Compare our sun to other stars

Describe one year as one revolution of the Earth around the sun

Observe the phases of the Earth's moon

Explain the effects of the Earth's tilt on temperature zones and seasons

Compare the characteristics of meteors, asteroids, and comets

Describe the progress of space technology and its effects on space travel

GRADE 5

PLANTS

Describe the reproduction of plants

Investigate and describe photosynthesis

Identify the life cycles of annuals and biennials

Explain respiration and transpiration (compare deciduous trees and conifers)

ANIMALS

Classify vertebrates (birds, mammals, reptiles, fish, and amphibians)

Classify invertebrates (porifera, coelenterates, worms, mollusks, arthropods, and echinoderms)

Describe the characteristics of muscles and the skeletal system for the purpose of locomotion

Investigate some aspects of social insects and relate them to human interactions

EARTH

Identify wind, water, and glacial erosion

List and describe harmful and useful effects of erosion

Identify and discuss the various landforms, such as buttes, mesas, plateaus, mountains, and valleys

Identify and locate the oceans

Research the ocean floor

Investigate ocean movements (waves and tides)

Explain ocean currents

Research resources from the ocean

ECOLOGY

Observe and describe a habitat, niche, and an ecosystem

Compare and contrast living communities

Describe the effects of natural and man-made changes in the environment

Give examples of prey-predator relationships

HEALTH

Identify the structure and functions of the skeletal, muscular, and nervous systems

Investigate human growth and development

Examine the structure and function of the digestive system

Describe the effects of drugs on the body

MATTER

Observe and describe the structures, properties, and states of matter

Demonstrate various measurements of matter (mass, volume, density, and length)

Confirm that a physical change is a change in the shape, size, or state of matter

Confirm that a chemical change is a change in matter in which one or more different kinds of matter are formed

Explain the benefits of being able to change the states of matter

ENERGY

Identify and compare various sources of energy

Recognize that electricity is a form of energy that results from the movement of electrons

Distinguish between static and current electricity

Construct and compare parallel and series circuits

Identify the uses of insulators and conductors

Identify ways of conserving energy

WEATHER

Use weather instruments to measure air temperature, air pressure, wind speed, and moisture in the air, and record results (incorporate into observing and recording daily weather)

Investigate and describe factors causing uneven heating of the Earth and atmosphere

Describe the effect of air pressure on wind direction and speed

Explain the source area, the movement, and the effects of air masses

Classify and explain the formation of clouds

SPACE

Identify several constellations

Describe and classify stars by size, color, and magnitude

Explain the life cycle of a star

Confirm that stars are found in large groups called galaxies

Identify some meteors, asteroids, and comets

Explain measuring scales used in astronomy

Demonstrate the relation of the sun to the phenomenons of seasons

Investigate the effects of the moon on tides

Investigate the benefits of space technology to our future

GRADE 6

PLANTS

- Classify plants according to their structure
- Investigate the process of plant growth
- Investigate plant adaptations to the environment
- Observe the growth changes due to the biological clocks
- Examine plant cell structure and reproduction through microscopic study

ANIMALS

- Classify animals as herbivores, carnivores, or omnivores
- Investigate vertebrates and invertebrates by comparing and contrasting
- Compare and contrast plant and animal cells
- Define the process of mitosis (single body cell division) and meiosis (reproductive cell division)

PROTISTS

- Classify the protists
- Define the characteristics of protists
- Investigate the importance of protists

EARTH

- List the Earth's natural resources
- Identify the uses of renewable and nonrenewable resources
- Investigate and discuss the methods of conserving our natural resources
- Consider the importance of recycling
- Describe how the Plate Tectonic Theory has influenced the Continental Drift Theory
- Describe the causes and effects of earthquakes and volcanoes

ECOLOGY

Classify organisms according to climatic regions

Observe adaptations and interdependence of plants and animals within our environment

Research and write about human survival adaptations

Explore career options in ecology

HEALTH

Describe the structure and functions of the circulatory, respiratory, endocrine, and excretory systems

Recognize the effects of heredity on physical traits

Identify emotional problems and feelings in puberty

Identify and describe factors of drug use and abuse

MATTER

Compare elements and compounds

Describe the motion of atoms and molecules in matter

Illustrate the structure of an atom including the three basic particles: electrons, neutrons, and protons

Recognize the difference between mass and weight

List the properties of acids and bases and give examples of each

Give examples of salts and describe how they are related to acids and bases

ENERGY

Construct, observe, and describe a magnetic field

Investigate the uses of electricity for communication

Describe and evaluate the effects of light on vision

Identify the uses of light in communications

Demonstrate and distinguish between reflection and refraction

Evaluate alternative sources of energy and their conservation methods

Identify ways computers have helped to conserve time and energy

WEATHER

Describe the varying climates

Explain how the winds and mountains affect weather and climate

Describe the weather conditions that cause thunderstorms, tornadoes, and hurricanes

Observe and record clouds

Identify and interpret the symbols on a weather map

Predict the weather using knowledge gained from available instruments

SPACE

Identify the instruments used to view outer space, such as light and radio telescopes

Investigate astronomy

Observe and describe gravity, inertia, and friction as they relate to space

Identify the planets which have natural satellites, such as moons

Identify the methods of space travel and exploration

INSTRUCTIONAL AIDS

HOW TO MAKE A COLLECTION OF INSECTS

Insect collecting is very interesting to many students and the booklet, "Entomology Manual," describes how to collect, kill, mount and classify. Insect collecting could become a hobby for the whole family. Very good for the beginner. To request copies of the booklet contact the Cooperative Extension Service, 4-H Bulletin Room, Morrill Hall, North Dakota State University, University Station, Box 5655, Fargo, North Dakota 58105, or contact the North Dakota State University Department of Entomology.

PREPARING AND MAINTAINING A FRESHWATER AQUARIUM

The following steps will assist in developing and maintaining a freshwater aquarium:

1. Have access to the necessary equipment. This includes a tank, filter, plants (anacharis, cabomba, vallisneria), a dip net, sand, fish, snails, and food.
2. Wash the tank thoroughly with soap and water. Rinse it several times to remove soap and to ensure cleanliness. Fill the tank and allow it to stand for about a day to provide additional cleansing and to provide a check for leaks.
3. Wash the sand with several rinsings in boiling water. Put about one inch of the clean sand in the bottom of the tank.
4. Lay a large sheet of paper on top of the sand before adding water. This prevents the water from stirring the sand.
5. Add water to within about an inch or two of the top. If tap water is used allow it to stand for a couple of days to permit the chlorine to escape from the water.
6. Add water plants along with water from which they were obtained.
7. Add a few rocks to provide a hiding place for the animals.
8. Provide about two snails for each gallon capacity of the tank.
9. Place in a position of indirect lighting. Avoid direct sunlight.
10. When adding new fish, float fish container in water until the fish water and aquarium water are at the same temperature.
11. Feed regularly. Avoid overfeeding. Clouding of water may indicate overfeeding.
12. Add water as needed.
13. Remove excess food, dead animals, and dead plants.

PREPARING AND MAINTAINING A WOODLAND TERRARIUM

A woodland environment can be simulated in the classroom through the following procedures:

1. Locate a suitable, waterproof, glass container for use as a terrarium.
2. Wash the terrarium thoroughly with soap and water. Rinse it several times with clean, clear water.
3. Place about an inch layer of pebbles on the bottom of the terrarium.
4. Place about an inch of sand on top of the pebbles.
5. Mix a small amount of crushed charcoal with some woodland soil which contains soil, twigs, and dried leaves. Place about an inch layer of the mixture on top of the sand.
6. Arrange ferns, mosses, lichens, liverworts, wintergreen, and other forest plants in the terrarium, and water thoroughly.
7. Place a snake, frog, newt, or turtle in the container.
8. Cover the container with a screen or plate of glass. If a glass cover is used, fresh air must be permitted to enter at regular intervals to prevent mold.
9. Add water as needed in order to keep the soil moist. However, do not permit the soil to become excessively wet.
10. Provide water and appropriate food for the animal kept in the terrarium.

PREPARING AND MAINTAINING A SEMIAQUATIC TERRARIUM

A shoreline environment can be simulated in the classroom through the following procedures:

1. Locate a suitable, leakproof, glass container for use as a terrarium.
2. Wash the terrarium thoroughly with soap and water. Rinse it several times with clean, clear water.
3. Prepare a layer of pebbles about an inch deep on the bottom of the container.
4. Using pebbles and sand, build up one end of the interior to about one half the height of the container.
5. Cover the built up area with soil.

6. Plant such things as mosses, ferns, arrowhead, partridge berry, wintergreen berry, lichen, liverworts, and creeping charlie in the soil on the raised portion.
7. Pour water in the shallow end of the container until a pond is created which takes up about half of the terrarium.
8. Place a turtle, salamander, frog, toad, or crayfish in the container.
9. Put a glass cover on the container.
10. Provide water and appropriate food for the animal kept in the terrarium.

PREPARING AND MAINTAINING A DESERT TERRARIUM

A desert environment can be simulated in the classroom through the following procedures:

1. Locate a suitable glass container for use as a terrarium.
2. Wash the terrarium thoroughly with soap and water. Rinse it several times with clean, clear water and dry it.
3. Cover the bottom with four or five inches of fine, dry sand. Use the red desert sand if it is available.
4. Plant cacti securely in the sand.
5. Add a desert animal such as a lizard or chameleon. Provide piles of rocks in which the animal can hide.
6. Place small cup of water, about the size of a soft drink bottle cap in the sand.
7. Cover the container with a screen top.
8. Sprinkle with water about every three weeks.
9. Provide water and appropriate food for the animal kept in the terrarium.

HOW TO PREPARE A SLIDE

1. Use clean slide and cover glass.
2. Put your specimen on the slide.
3. Very carefully add a single drop of water.
4. To cover the specimen with a cover slip, touch one edge of the cover slip to the drop of water, then gently lower the cover onto the specimen. Keep the bottom of your slide dry.

1

bowl of water
paper
marking pen

1. Collect 12 different small rocks from many places. Place them in an egg carton.
2. Putting a small piece of masking tape on each rock, number them.
3. To find out about each rock, complete the following chart.
4. Read each question. Put an X under the rock number if the answer is yes.

- a. Does the rock have two or more colors?
- b. Does the rock have large mineral pieces?
- c. Does the rock have small mineral pieces?
- d. Is the rock sandy?
- e. Does the rock have many holes?
- f. Does the rock have layers?
- g. Does the rock have bands?
- h. Does the rock have an odor?
- i. Is the rock shiny?
- j. Is the rock rough?
- k. Is the rock heavy?
- l. Does the rock float in water?
- m. Does the rock make marks on paper?

[illegible]

5. Group the rocks with like properties.
 - a. How many rock groups did you have?
 - b. How did you group the rocks?

HOW TO MAKE A PLANT COLLECTION

A collection of well preserved and accurately identified plants is a valuable aid to the elementary teacher.

Several points must be observed in making a good collection. The plants must be dried quickly for good color retention and they must be dried under pressure to prevent wrinkling.

Plants which are average in size, reasonably complete, and relatively free of insect or other damage are preferred. Since classification and identification are largely based on the reproductive parts, especially in flowering plants, it is highly desirable to select plants which bear these.

A complete specimen of herbaceous plants includes the root system as well as the aerial portions. In the case of woody plants a representative part of a branch, usually a terminal portion, should be selected and cut off with the pruning shears.

Taking notes at the time the collecting is done is necessary. Each plant should be checked as to flower color, odors present, and other data which may be lost in drying. Also, ecological conditions of the area should be briefly noted. Finally, the date, locality, and name of the collector should be recorded.

Each plant should be assigned a reference number which is entered in the book. A small piece of paper bearing the same number should be placed with the specimen and kept with it during its subsequent processing.

A folded half sheet of newspaper serves to hold each specimen while it is drying. When the plant is placed in the paper, the leaves should be arranged so as to show the underside of at least one leaf and the upper sides of others. Flowers should likewise be arranged. (After the plant is dry, attempts to arrange it usually result in breaking the specimen.)

After a satisfactory arrangement is made, the folded half sheet of newspaper containing the plant is placed between two botanical driers (sheets of blotting paper) to absorb moisture from the specimen. This is then placed between corrugated cardboard. The ribs of the corrugation should be in contact with the blotters to permit the air to reach the latter.

When all of the plants have been thus prepared they are stacked and placed between the panels of the plant press, and the straps tightened securely. Rapid drying is desirable because color is retained better.

Once the plants are well dried they can be left in the folded newspapers and stored in boxes. However, to permit freer handling, mounting on standard 11 1/2 inch by 16 1/2 inch tagboard sheets is recommended. The plants are fastened to the sheets with a good glue or herbarium paste. To apply adhesive, take a sheet of glass or smooth metal about the size of a herbarium sheet or larger and brush a thin layer of glue over the entire surface. Carefully lay the dried plant on the glue making sure that all parts are in contact with it. Then carefully lift the plant and lay it on the herbarium sheet in the exact spot where it is to remain. (Attempting to apply glue directly to the plant by brushing it on usually results in a damaged specimen or a messy mount.)

For especially heavy or stiff, woody specimens, small strips of gummed tape can be used to provide secure attachment of the stems. Even in this instance, the use of glue or paste is recommended to fasten the leaves tightly to the sheet.

A label should be attached to the lower right corner of the herbarium sheet. Information to be included on it is:

- Plant family
- Name of plant (scientific and common)
- Where collected
- Date collected
- Name of collector
- Miscellaneous (ecological data, etc.)
- Reference number

Storage in herbarium folders protects the specimens. The stacks of folders can be placed in boxes, on shelves, or best of all, in a cabinet. Since insects do attack dried plants, the use of moth crystals or similar repellent is recommended. The data book, which usually contains more information about the plants than is recorded on the sheets, should be kept with the collection.

Dry fruits such as nuts can be stored in envelopes or boxes. Fruit which has been removed from a specimen mounted on a herbarium sheet should be given the same reference number as the sheet in order to identify the source plant.

To preserve fleshy fruits or flowers, fill a shoe box with borax, baking soda, or sand. Carefully bury a freshly cut flower. Contact a florist for some flowers if none are available outdoors due to the season. Put the box aside for several weeks. Carefully remove the flower. The flower should look as if it has just been cut. Compare the preservation of the flower to the preservation of organisms in sand or volcanic ash.

HOW TO DRY PLANTS IN THE MICROWAVE OVEN

Procedure:

1. Arrange plant flat between two layers of paper towel. Avoid towels with a raised pattern.
2. Put towels with specimen between two layers of ordinary cardboard and put in microwave oven.

3. Place five or six stoneware dinner plates on top for weight.
4. Use the defrost setting (25%-40% power) and set the timer for two to five minutes. You will need to experiment with each different plant. The variation in time is due to variations in the waxiness and juiciness of different plants.
5. Specimens will come out of the oven quite flat and limp. Allow the specimen to air dry for 30-60 minutes before mounting it.

For use in plant collection assignment, these pressed and dried specimens are lightly glued to 5" x 8" posterboard, labeled, and covered with clear "Contac" brand plastic material. They maintain their shape and color for up to ten years when prepared in this manner.

From: Iowa Science Teachers Journal, Spring, 1986

SAFETY IN SCIENCE TEACHING
THE ACT - NDCC 65-14

Your Right to Know Law

A new chapter to Title 65 of the North Dakota Century Code was created and enacted to protect teachers and students from hazardous substances. Each employer shall implement an employee information program designed to inform employees about hazardous substances to which they are exposed. This information must include the nature of the hazard, appropriate work practices, protective measures, and emergency procedures. "Hazardous substances" means a chemical or substance which is defined as a hazardous substance under the Federal Comprehensive Environmental Responses Compensation, and Liability Act of 1980, as amended, (P.L. 96-510; Stat. 2767; 42 U.S.C. 9601 et seq.), and meets or exceeds the listed reportable quantity for that substance.

Essentially what this law states is that as an employee you are provided the right to be informed of any hazardous chemical substance to which you may be exposed to in your work place. To get more information contact your school administrators and/or the North Dakota Workers Compensation Bureau, Russel Building, Highway 83 North, 4007 North State Street, Bismarck, North Dakota 58505, telephone 701-224-2700.

Because good science instruction involves the use of a wide variety of equipment and material, the risk of accidents and injury is always present. Therefore teachers are urged to be aware of precautions which can be taken to reduce this risk. Your Right to Know Law moves in the direction of protecting you and your students from hazardous chemicals.

It has long been recommended that the following chemicals are not suitable for elementary classroom use or storage:

1. carbon tetrachloride
2. sodium or potassium metal
3. asbestos products
4. formaldehyde
5. ether
6. fiberglass
7. radioactive material
8. chlorine
9. mercury

The Your Right to Know Law has added many more to the earlier list of chemicals that should be restricted or stored in safety cabinets with suitable labels. Some of the flammable hazards that need to be stored in special storage in the classrooms are the alcohols, cleaning fluids, ditto fluids, petroleum products, and metal powders.

In addition to the flammable hazards a new list of carcinogens has been compiled and these should be stored in a secure poison area and preferably not in an elementary classroom. Carcinogens are substances capable of causing cancer or cancerous growths in mammals. Asbestos, carbon tetrachloride, formaldehyde, and benzene have been banned from use in schools for many years. The newer list includes some chemicals that are frequently found in elementary classrooms. These chemicals got into the classrooms via some of the National Elementary Science Curricula of the 60s and 70s. This is not an exhaustive list but fairly adequate for your protection against carcinogens as of this date:

1. ammonium dichromate
2. aniline (or any of its salts)
3. cadmium chloride
4. cobalt powder
5. hydroquinone
6. potassium chromate
7. potassium permanganate
8. pyrogalic acid
9. silver nitrate
10. sodium nitrate

These ten substances and the additional four carcinogens listed earlier should be removed by a trained science teacher, e.g., high school chemistry teacher, health authority, or licensed commercial company. Once removed the substances should not reenter the school and instructions should be added to the procedure for ordering chemicals to make sure that, once removed, these chemicals are not reordered.

Another chemical that has made its way into some elementary classrooms is the substance barium hydroxide which is used for testing carbon dioxide. Barium hydroxide is extremely toxic and should be replaced with calcium hydroxide for testing carbon dioxide.

Some elementary schools have a central storage for science equipment and chemicals. The chemicals stored in this area should be checked by a trained science teacher who has completed a science safety course such as Safety in the School Science Laboratory. For further information write: U.S. Consumer Product Safety Commission, Washington, DC 20207. Toll-Free Hotline: 800-CPSC or 800-639-2772.

General Safety Practices

1. A teacher should work through the handling of equipment and materials, find out about possible hazards and be sure that the experience is a reasonably safe one before proceeding.
2. Teachers should practice general safety procedures in relation to the use of fire and instruct children to take appropriate precautions. In consultation with the building principal, the teacher should be aware of the district policies for the use of flame and hazardous materials.

3. At the beginning of any experience, if there is any special hazard, children should be instructed regarding the potential hazards and the precautions to be taken. These precautions include both classroom experimentation and field trips.
4. If children are working in groups, each group should be as small as possible with sufficient room to prevent confusion which might result in accidents.
5. When using equipment that might present special hazards, individual and group work should be arranged in the classroom so there can be constant teacher supervision.
6. All accidents resulting from the handling of equipment should be reported to the teacher, recorded and reported to the principal and finally to the parents.
7. Children should never carry equipment through the halls when classes are changing.
8. Children should be allowed sufficient time to perform experiments.
9. Any piece of equipment that has been heated (microprojector, hot plate, A.C. devices) should not be moved until it has cooled.
10. Hazardous materials and equipment should be used in a classroom only when necessary. These materials should be stored in an approved locked area.
11. Before permitting children to work with sharp tools, the teacher should be assured the children are competent to use these tools and are closely supervised while the tools are being used.
12. There is always danger when heating a liquid. Be sure to check that liquids will not boil dry or spatter on students.
13. Glass wool and steel wool should be handled with gloves.
14. Keep a neat and tidy work area.

Safety in Relation to Animals and Plants

1. All mammals used in a classroom should be inoculated for rabies, unless purchased from a reliable scientific company.
2. The following animals should never be brought into the classroom: wild rabbits, snapping turtles, poisonous snakes, or insects that may be disease carriers. Children should not bring their pets to the classroom unless the activity is carefully planned by the teacher, and each animal has received appropriate shots.

3. Before a small animal is brought into the classroom for observation, plans should be made for proper habitat and food. The living quarters of animals in the classroom should be kept clean, and secure enough to confine the animals. Plans should be made for care of the animals over the weekend and during vacation periods.
4. Animals should be properly handled and then only when necessary. Note: Special handling is required if the animal is excited, is feeding, is pregnant, or is with young.
5. Children should wash their hands after handling turtles, frogs, snakes, fish, toads, etc. Also the water from the habitat should be disposed of carefully.
6. Children should be cautioned never to tease the animals or insert their fingers or objects through wire mesh cages.
7. If any child is bitten or scratched by an animal, the teacher should seek appropriate medical attention.
8. After a period of animal observation is completed, animals should be returned to their natural environment.
9. Before taking study trips into wooded areas, identify and discuss plants which produce poisonous effects.
10. The use of flowers and mold which have excessive spores should be used with caution because of possible allergies of children.
11. Because of the danger of contamination the use of bacteria cultures are not recommended in the elementary classroom.

Safety With Electricity

1. At the beginning of the study of a unit on electricity, children should be told not to experiment with the electric current of home and school circuits.
2. Children need to be taught safety precautions regarding the use of electricity in everyday situations.
3. Children should never handle electric devices immediately after their use because these devices might retain a high temperature for a long period of time.
4. To remove an electric plug from a socket, pull the plug and not the cord.
5. It is to be recognized that short-circuited dry cells can produce a high temperature which can cause a serious burn.
6. Storage batteries may be dangerous because of the acids they contain and the possibility of short circuits within them.

Safety With Glassware

1. All glassware that is to be heated should be made of a heat-treated glassware such as Pyrex.
2. All glass tubing should be polished or have the edges beveled with emery paper.
3. A soap solution or glycerine should be used on the top of glass rods or tubing for lubrication before inserting them into a cork or stopper. Tubing should be wrapped with several layers of cloth or in a rubber tubing holder. The tubing should be held as close to the cork as possible and inserted with a gentle twisting motion.
4. When not in use corks should be removed from tubing to keep them from "freezing." "Frozen" stoppers can be removed by splitting them with a razor blade and then reclosing them with rubber glue.
5. Broken glassware should be disposed of in a special container marked "BROKEN GLASS."
6. The fingers should never be used to pick up broken glass. A wisk broom and dust pan can be used for large pieces, and large pieces of wet cotton can be used for very small pieces.
7. Glassware should be thoroughly cleaned and dried after use.
8. Children should never drink from glassware that has been used for science experimentation.
9. Sharp edges on mirrors or glassware should be reported to the teacher.
10. Glass objects which might break should be wrapped with plastic wrap or wire screening.

Safety With Heating Devices

1. Cans of solidified alcohol or canned heat should not be used without strict teacher supervision for experiments in the elementary grades.
2. Electric "hot plates" can be used where only heat and not flame is necessary. Safety precautions must be exercised to eliminate possible burns.
3. When heating liquids on a hot plate, beakers and flasks made of Pyrex-type glass may be placed directly on the burners. This should be done only by the teacher.
4. The heater should be equipped with an on-off switch so that it will not be necessary to pull the wall plug out after each use.
5. Candles, as a rule, are not satisfactory for heating and should be used only in specified activities.

6. A teacher should use extra precautions with an open flame around children.
7. If a bunsen burner is used, it should be lit only by the teacher and placed in a position where children will not burn themselves or their clothing.
8. The teacher should be familiar with all heating devices before using them in class.
9. When using an open flame, such as candles, have a quantity of water, baking soda, or a fire extinguisher available.
10. Keep long hair and loose clothing away from open flames.

SCIENCE EQUIPMENT AND MATERIAL

Ideally it is desirable to have a special room to teach science where there are moveable tables, storage, utilities, display area, plant and animal areas, and long-term project areas available. Self-contained classrooms serve most adequately when they have sinks, water, electrical outlets, facilities for using audiovisual aids, bulletin boards, storage space, and work area. In some cases if storage is not adequate, students can arrange their desks in groups and do most of the science activities.

A modern elementary school science program should be one that includes student and teacher experimentation and investigation. A program of this type cannot be accomplished without a supply of equipment and materials sufficient to allow the involvement of all the children. The materials and equipment used at the elementary science level should be simple, easy to handle, and readily available. The supplies fall into these general categories: 1) those which can be brought in by the children from their homes or easily obtained by the teacher from the community; 2) those which can be obtained from the science teachers in the secondary schools of the system; 3) those which must be purchased from scientific supply companies; and 4) those which may be made by the teacher and/or students.

Obtaining Supplies

Science equipment and supplies can be obtained from commercial suppliers. See page 63.

The following is a suggested list of materials to teach elementary science. The quantity of each item will depend upon how large the school is, how much individual experimenting is to be done, and whether or not this equipment is to be routed from one school to another. Some school systems prepare kits of material useful for teaching specific units (electricity, sound, etc.) which are available upon request from a central place and are returned after use. Many items may be purchased locally.

Life Science

Animal cage
Aquarium
Cover glass
Dissecting set
Growing plants
Insect collection
Leaf collection
Magnifying glass
Microscopes
Models of body parts

Plant/Animal
Identification Guide
Plant press
Pots for plants
Seed collection
Stethoscope
Slides, blank
Slides, prepared
Terrarium

Earth Science

Anemometer
Balls, assorted sizes
and weights
Barometer
Celestial globe
Cloud chart
Compass
Fossil collection
Globe, physical
Hardness kit
Hygrometer
Inside thermometer
(Fahrenheit-Celsius)

Mineral collection
Outside thermometer
(Fahrenheit-Celsius)
Rain gauge
Rock collection
Rock/Mineral Guides
Solar system model
Star guide
Streakplates
Sun dial
Telescope
Weather map
Weather vane

Physical Science

Ammeter
Balances and weights
Ball and ring
Bar magnets
Cellophane (colored)
Concave-Convex mirror
Convex lens
Compass (magnetic)
Copper wire
Copper/zinc plates
Dry cells
Electric bulbs, small (1 1/2 - 2 volts)
Electric motor
Electric sockets, small
Electric bell
Electromagnet
Flashlight
Glass friction rod
Graduated cylinder
Hot plate

Inclined plane
Inclined plane car
Iron filings
Lodestone
Magnifying lens
Meter sticks
Paper (colored)
Prism
Pulley
Push button
Rubber friction rod
Ruler (inches and centimeters)
Scales (spring)
Slinky toy
Switches
Telegraph key and sounder
Thermometer
(Fahrenheit-Celsius)
U magnet
Voltmeter

Miscellaneous

Ammonia
Aprons
Bags, paper
Baking soda
Beakers
Boxes
Burette clamp
Burner, propane
Candles
Clay
Corks
Droppers
Dyes
Evaporating dish
File
Flasks
Food coloring
Funnels
Glass tubing
Gloves
Hammer
Jars
Knife
Litmus paper
Marble chips
Marbles
Matches
Metric measuring tools
Nails, screws, washers

Petroleum jelly
Pins
Plaster of Paris or
rock putty
Plastic bags
Pliers
Pot holders
Ring stand
Rubber bands
Salt
Sandpaper
Screwdriver
Sponges
Starch
Steel wool
Straws
String
Stopper, rubber
Sugar
Tacks
Tape
Test tube brush
Test tube clamp
Test tube holder
Test tubes
Tin snips
Tongs
Tubing
Vinegar

Storing Materials

Some elementary schools have science rooms especially equipped for science instruction and storage of equipment. If these are not available, a central science depot and storage room might be established. The room should be readily accessible to all teachers and should be under the supervision of a teacher familiar with the equipment. To facilitate checkout and use by teachers, the materials should be arranged and stored according to a topic plan. For example, small items can be stored in appropriately labeled plastic tote trays or discarded shoe boxes. Some of the trays might be labeled "electricity," "magnetism," "rocks and minerals," and so forth. This system facilitates the moving of science materials from room to room by the teachers or children using carts.

Microscopes

What kind of optical equipment should schools use in the elementary grades? It seems as if the student should not begin with a high power compound microscope. It also seems that the students' ability would determine what instrument to use.

The young student should start with a single lens type of magnifying glass. He would learn and understand magnification. He would understand what is meant by ten power, one hundred power and four hundred power. The next step in the grades would be to use the compound microscope with magnification of, generally, five to thirty power.

Small, inexpensive microscopes have been developed by some of the National Curriculum Studies, such as the Elementary Science Study, that have proved adequate for their units. The magnification and clarity of the lenses in these inexpensive microscopes is generally satisfactory for the type of visual exploration required. They also help children to understand the workings of the more sophisticated instruments. In addition to these inexpensive microscopes, it is desirable to have the more "professional" compound microscope available for in-depth investigations.

The microprojector has found its use in many classrooms. It will project slides and small specimens which require great magnification. Groups of students or, in some cases, the entire class may view the slide or specimen at the same time. It provides for group participation and reaction.

FIELD TRIPS

Field trips are indispensable in developing the concepts of science. They provide a sense of reality to the classroom experience as well as a means for informal instruction.

Each field trip should be a thoroughly planned activity. This planning includes clearly articulated objectives that are consistent with classroom objectives. Also, classroom activities that properly prepare the students for the trip and post trip activities that reinforce what was learned on the trip are equally important.

A field trip should not be an isolated experience that is taken on the last day of school as a reward or use up time. Rather, the experience should be meaningful with clear objectives. These objectives should not only be science related, but involve all areas of the curriculum such as reading and writing. This integration not only makes the experience more meaningful to the student and school, but also demonstrates how academic areas are not isolated, but rather interrelate with one another.

A well planned field trip involving the principal and parents will provide a long lasting experience for the student.

Preliminary Planning

Permission slips distributed and returned

Purpose of trip and destination

Time of departure and return

Appropriate clothing (jackets, boots, etc.)

Note specific things relating to trip objectives

Equipment needed, if any

Safety precautions

Necessity of keeping together and with the leader

Arrange for transportation

Consider the need for chaperones

Conducting the Trip

Be sure that all comments on observations are simple and adapted to the level of the group.

Encourage questions and be sure that all hear and understand the questions and answers.

Give more than facts and names; if possible, present "human interest" information about items seen.

Make the most of unexpected occurrences and observations volunteered by the group.

Summary of the Trip

Discuss the highlights and important findings. This is properly done as soon as possible after observations have been made and relationships pointed out. The summary should be made in the classroom immediately upon returning. The important thing is that the trip should be timed so as to provide ample opportunity for a summary.

Types of Field Trips

Airport
Bakery
Chicken Hatchery
Creamery
Dairy Farm
Farms
Fire Department
Fish Hatchery
Greenhouse/Nursery
Grocery Store
Hospital/Clinic
Industrial Plant
Lakes or Ponds
Local College
Meat Packing Plant
Mines
Museum

Nature Trail
Newspaper Office
Parks
Pet Shop
Photo Processing Plant
Planetarium
Power Plant
School Neighborhood
Sewage Treatment Plant
State Parks
Telephone Company
Television/Radio Station
Tree Farm
Veterinary Clinic
Water Treatment Plant
Weather Station
Zoo

SCIENCE FAIRS

Studies suggest that the elementary child is curious, and that natural curiosity can be directed to scientific investigation. A practical approach to using this curiosity and encouraging scientific investigation would be to conduct a science fair. Science fairs reinforce what students learn in a good science program. Because fairs build inquiry skills, students are soon asking researchable questions, gathering information, and drawing their own conclusions.

Probably the biggest advantage in holding a science fair is involving each student in a project. These projects generate far more interest in science than an individual teacher could ever do. These projects allow students to develop their own ideas in a manner and depth that has meaning to them.

In addition, several other advantages can be cited for conducting elementary science fairs:

1. Science projects are an effective means of stimulating a child's imagination and encouraging independent thinking.
2. Making science projects allows for expression of individual differences.
3. Science projects can be used to help children learn some of the processes of science.
4. Working on science projects can cause genuine excitement in the classroom.
5. Working on science projects can be a meaningful interdisciplinary activity.
6. Science fairs make for good public relations. Ultimately, you will have to decide what you hope to achieve, who will participate, how the fair will be organized, and how projects should be judged (if at all). Be assured that a successful fair requires much effort, but the rewards are everlasting.

Resources

Science Fairs and Projects, National Science Teachers Association,
1742 Connecticut Avenue Northwest, Washington, DC 20009.

Science Service, Inc., 1719 N Street Northwest, Washington, DC 20036.

North Dakota Department of Public Instruction, Curriculum Division, Capitol
Building, Bismarck, ND 58505-0440.

Native American Science Fair.

Suggestions for Fair Projects

1. Start with materials and ideas that are readily available. A lot of time and energy can be wasted looking for hard-to-get materials.
2. Set a target date at least two weeks before the actual science fair for completion of projects.

3. From the start, keep parents informed about the project and encourage some parental involvement.
4. It is suggested students do all of the printing and drawing. Before final copies are made, go over everything, checking spelling, grammar, punctuation, content, and clarity. Always involve students in this process, it serves to reinforce language arts skills.
5. Avoid using fancy lettering, borders, or elaborate pictures. Do have neat, accurate charts, and graphs.
6. Be sure the backboards are large enough to display necessary materials.
7. Decorate the backboards using complimentary colors with accent colors for borders and lettering.
8. If it is appropriate, give the project a catchy title. Otherwise, restate the hypothesis as a short, simple title.
9. If possible, schedule work on projects during the part of the day you feel best. Stop work when pupils are tired, bored, or creating problems.
10. Insofar as possible, let each child select his own topic, or pose his own question. Children resist having to make forced choices from lists.
11. Give students experience in sharing work they have done by allowing time for them to explain their project to other members of their class or other classes.
12. Projects should be original rather than commercially prepared kits.
13. Projects should not include live species of the animal kingdom, open flames, harmful chemicals, or bacterial cultures.
14. Projects should not be library reports. They should contain some degree of creativity and inquiry.

EXAMPLE OF AN ELEMENTARY SCIENCE PROJECT

I. Backboard

A. No wider than 48 inches and no taller than 72 inches

B. Must show the following:

1. Title
2. Purpose
3. Procedure
4. Observations, finding, or results (pictures, charts, or graphs)
5. Conclusion

C. Must be able to stand up on its own

D. Must be neat and legible

II. Booklet

A. Contents

1. Research
2. Pictures, charts, or graphs
3. Bibliography
4. Cover-Title
5. Neat and legible

III. Display

- A. Investigation relating to title
- B. Neatness
- C. Set up using scientific procedures

SCIENCE FAIR CHECKLIST

- _____ Set time, date, and place well in advance and clear with administration.
- _____ Draft science fair rules (entry deadline, size limits for display, requirements for final report and log of observations, completion deadline, and judging guidelines, if necessary). Urge experiments rather than reports.
- _____ Design entry form (name, project title, hypothesis, process materials, places for student and parent signatures).
- _____ Make up lists of suggested topics. Check with teachers, librarians, and science texts for ideas.
- _____ Publicize 1) application deadline, 2) science fair night, and after the fair has taken place, 3) the winners (if projects are judged).
- _____ Order ribbons and certificates for participating students. It is recommended that all students receive an award.
- _____ Plan arrangement of projects to allow plenty of room for spectators.
- _____ After the fair is over, send thank you notes to parents, teacher volunteers, and judges (if used).

If Projects Are to Be Judged

- _____ Design final report form (student number, project title, grade, hypothesis, process, summary of observations, conclusions). Do not leave space for student's name because projects are to be judged anonymously.

_____ Design judge's evaluation form (number and title of project, boxes for scores in each category).

_____ Find judges (preferably from outside the school system).

Suggested Criteria for Judging

Creative ability	35
Scientific thought	35
Thoroughness	20
Neatness	<u>10</u>
	100

SCIENCE CLUBS

Science clubs can serve as an extension from the regular classroom. Students can be motivated to join the club early in the year with a time and place for the first meeting to be set. Some ideas that could be included in a club are:

1. Interesting field trips into the community.
2. Extension of projects from the regular classroom.
3. Group projects such as tree planting, building a telescope or setting up an aquarium.
4. Help organize a science fair.
5. Have a group money-raising project so groups can finance their own trips, club purchases, etc.
6. Do group research. An example could be weather forecasting over the course of a year.
7. Have guest speakers come to speak. Examples include county agent, a high school or college instructor, or a game and wildlife specialist.
8. Elect a president, a vice president, treasurer, and secretary.
9. Science videos, movies, or filmstrips could be watched. Discussions or debates could take place afterwards.
10. Students could explore careers in science by interviewing people in the community.

Resource

Young Astronaut Council, P.O. Box 65432, Washington, DC 20036.

INSERVICE TRAINING FOR SCIENCE TEACHERS

Inservice training is essential to the development and implementation of an effective science program. The quality of science instruction at any level is determined largely by the capability of the classroom teacher. Inservice training is one approach to improving teaching competence. The inservice suggestions listed below are several ways local school districts might explore ways to improve their science programs.

1. Schools should contact the science consultant in the Department of Public Instruction as to the possibilities of an inservice training program.
2. Use science teachers, college instructors, or other resource persons to conduct workshops.
3. Teachers should attend classes or workshops.
4. Conduct meetings for sharing instructional materials and ideas.
5. Allow release time for observation of other science programs, effective teachers, and innovative activities.
6. Have a committee for continued evaluation and growth of the science program. Members should include primary, intermediate, junior high, and senior high faculty.
7. Provide assistance for new teachers to improve their lesson planning, their science techniques, and their utilization of materials in the classroom.
8. Increase professional and reference libraries.
9. Stimulate interest in exhibits, demonstrations, and fairs.
10. Encourage teachers to be aware of current topics or concerns.
11. Have at least one teacher join the North Dakota State Science Teachers Association.
12. Have a well articulated science curriculum including objectives and scope and sequence.
13. Collect curriculum guides from other school systems.

INSERVICE TRAINING BIBLIOGRAPHY

- Apelman, M., Morrison, P., and Hawkins, D. (1985). Critical Barriers Phenomenon in Elementary Science. Grand Forks, ND: Center for Teaching and Learning, University of North Dakota.

- Bybee, R., Peterson, R., Bowyer, J., and Butts, D. (1984). Science and Society/Activities. Columbus, OH: Charles E. Merrill Publishing Company.
- Cain, S. E., and Evans, J. M. (1984). Sciencing (2nd ed.). Columbus, OH: Charles E. Merrill Publishing Company.
- Collette, A. T., and Chiapetta, E. L. (1984). Science Instruction in the Middle and Secondary Schools. St. Louis: Times Mirror/Mosby College Publishing.
- Davis, G. A. (1983). Creativity Is Forever. Dubuque, IA: Kendall/Hunt Publishing Company.
- Dorn, M. S. (1987). Children's Questions. Workshop Center, Room 4/220, North Academic Center, City College School of Education, New York.
- Esler, W. K., and Esler, M. K. (1984). Teaching Elementary Science. Belmont, CA: Wadsworth Publishing Company.
- Good, R. G. (1977). How Children Learn Science: Conceptual Development and Implications for Teaching. New York: Macmillan Publishing Company, Inc.
- Hands-on, minds-on science: Are you ready to teach it? (1987). Instructor Magazine, Special Issue, New York.
- Henson, K. T., and Janke, D. (1984). Elementary Science Methods. New York: McGraw Hill Book Company.
- Kavaler, L. (1981). A Matter of Degree. Cambridge: Harper and Row, Publishers.
- Morrison, P., and Morrison, P. (1984). Primary Science: Symbol or Substance. The City College Workshop Center, New York.
- Roche, R. L. (1977). The Child and Science: Wondering, Exploring, Growing. Washington, DC: Association for Childhood Education International.
- Stevens, P. S. (1974). Patterns in Nature. Boston-Toronto: Atlantic-Little, Brown and Company.
- Tributsch, H. (1982). How Life Learned to Live. Cambridge, MA: The MIT Press.
- Victor, E. (1975). Science for the Elementary School (3rd ed.). New York: Macmillan Publishing Company, Inc.
- Vitale, B. M. (1982). Unicorns Are Real: A Right-Brained Approach to Learning. Rolling Hills Estates, CA: Jalmar Press.

SCIENCE CAREER EDUCATION

Helping individuals make informed career decisions is a critical and continuing need. One of the best means of addressing this need in a practical and lasting way is through our educational institutions.

Elementary students should be competent in their relation to the world-of-work and understand a) the nature of work, b) the nature of occupations, c) work values, and d) the effect change has on work.

Career information can be presented to students in two ways: 1) infusing career information into the existing curriculum and 2) adding career development activities to the curriculum.

Career infusion is intended to:

- o emphasize the goal of education as preparation for work
- o be a part of the curriculum, not an additional course
- o motivate students to acquire skills, knowledge, and attitudes related to career development
- o provide relevance to regular subject matter in the curriculum
- o increase the amount of subject matter students actually learn

Infusion means to "weave" career-related content into existing courses in the curriculum therefore teaching subject matter and career content simultaneously. Examples of infusion include:

1. complete math problems in which the amount of carpet needed to cover a living room floor is computed
2. read an article related to lifestyles of different occupations and write statements of the main idea
3. draw pictures of adults in situations at work and at home
4. learn spelling words that relate to scientific research
5. relate lifestyle and occupations in an agricultural community versus a logging community (space industry, water transportation, or fishing community, etc.)
6. using a road map, compute distance and routes between North Dakota cities

Examples of add-on activities include:

1. guest speakers such as biologists from factories, laboratories, government, etc.

2. taking students on a tour of a laboratory, hospital, clinic, etc.
3. selecting science related jobs in the classified section of the newspaper
4. list the tools-materials-machines that are used by a biology teacher, medical technologist, licensed practical nurse, etc.

After children enter school they begin to learn more and more about themselves: They like some things better than others, and they do some things better than others (interests and aptitudes). They begin thinking about occupations and classifying them; and they form some notion of what they want to be. Classroom teachers should take advantage of students career readiness by encouraging them to link their aptitudes and interests to science careers while simultaneously adding relevance to the curriculum. Infusing career information into classroom teaching should be planned as the curriculum is written. As the program is delivered to students, career information will be delivered. Demonstrating the application of science to jobs and the labor market will direct students toward career selection and afford them an opportunity to become aware of professional opportunities in science and technology. Incorporating career development principles into the curriculum and imparting career information to students prepares them to make informed career choices, and ultimately prepares them to be more satisfied workers.

GENERAL SUGGESTIONS FOR USE OF THE CAREER OUTLOOK

Listed below are some suggestions that may be used in the classroom with students who are exploring careers. This list is by no means exhaustive, but is designed as "FOOD FOR THOUGHT." You will think of more innovative uses.

1. Choose an occupation from the CAREER OUTLOOK. List all of the industries where you could be employed with that occupation (example: Nurse; hospital, nursing home, industrial plant, school, home).
2. It is estimated that a significant number of high school graduates remain in their local community to seek employment. List the employers in your community. Which occupations listed in the CAREER OUTLOOK fit into those industries.
3. Locate five occupations that show an "outlook" of C (fewer jobs than people trained to fill the jobs). What factors may contribute to the lack of opportunity in these occupations?
4. How many of the 317 occupations listed in the CAREER OUTLOOK require:
 - a. less than a four-year college degree
 - b. a graduate or professional degree
 - c. vocational training
 - d. are apprenticeshipable

5. How should you dress if you are going to an interview for a job as a construction laborer (bricklayer, carpenter, teacher, engineer, occupational therapist, etc.)?
6. List ten jobs that have entry level salaries below \$7,000 (above \$20,000).
7. Which institutions would you choose to attend if you wanted to pursue a career as a nurse (mechanic, carpenter, etc.)?
8. Divide your class into two teams. The goal for each team is to list the most occupations from the following questions:

List all of the occupations in which you would . . .

wear a suit (dress, jeans, safety shoes, white, etc.)
 use a car, van or truck
 use a lathe (hammer, saw, trowel, camera, etc.)
 use a typewriter (computer, copy machine, etc.)
 use a stethoscope (needle, sponge, syringe)
 travel daily
 write a lot (speak frequently, listen carefully)
 use test tubes (beakers, microscopes, scales)
 use paint (canvas, brushes, ladders, etc.)
 need acute vision (hearing, touch, etc.)
 wear ear protection (safety glasses, seat belts)
 work outside (inside, both inside and outside)

SCIENCE CAREER EDUCATION BIBLIOGRAPHY

BUSINESS WEEK CAREERS

- published six times per year
- deals with careers, skills, internships, interview techniques, personal life issues and lifestyles that keep pace with a changing and complex world
- geared more for postsecondary and adult, an excellent reference

Business Week Careers
 McGraw-Hill, Inc.
 1221 Avenue of the Americas
 New York, NY 10020

CAREER WORLD

- published monthly, September through May
- highlights careers giving in-depth information about growth in the field, related professions, job descriptions, training and other characteristics

- activities designed to focus attention on careers, training, decision making

Career World
P.O. Box 310
Highwood, IL 60040

CHILDREN'S DICTIONARY OF OCCUPATIONS

- introduces children to the world with over 250 occupational titles and descriptions
- color illustrations included

Meridian Education Corporation
205 East Locust
Bloomington, IL 61701

ENVIRONMENTAL PROTECTION CAREERS GUIDEBOOK

- provides detailed overview and description of over 100 different occupations

Superintendent of Documents
Government Printing Office
Washington, DC 20402-9325

GUIDE FOR OCCUPATIONAL EXPLORATION

- provides readily understandable and useful information about fields of work with which career decision makers can match their own interests and abilities
- lists significant occupational clues and relates each clue to work clusters
- provides information regarding skills, interests, aptitudes, training and job preparation

American Guidance Service
Publishers Building
Circle Pines, MN 55014

HEALTH CAREERS GUIDEBOOK

- describes jobs, opportunities and training for each area of health care professions

Superintendent of Documents
Government Printing Office
Washington, DC 20402-9325

OCCUPATIONAL OUTLOOK HANDBOOK

- discusses broad national trends that shape the economy and world of work
- describes in detail 200 occupations including nature of the work, working conditions, employment, training and advancement, job outlook, earnings, and related occupations

Superintendent of Documents
Government Printing Office
Washington, DC 20402-9325

COMPUTERS IN SCIENCE EDUCATION

With computers now readily available in most schools, and with the increasing availability of good software, it is clear that computers will become major tools of education. With the continuing efforts by the computer industry to provide "user friendly" software, schools no longer need an expert programmer to make use of current computer technology. The best role of computers in the educational process must be assessed by the school.

A method to improve the problem solving abilities of students is to have them create their own programs. This does not necessitate developing an extensive ability to program, but rather may simply involve the utilization of a limited number of commands of one language such as LOGO or BASIC. Programming forces the student to define the problem, formulate, implement, and evaluate a plan. This can be accomplished in a nonthreatening environment, with immediate feedback and reinforcement while challenging the student's creativity.

In teaching science, as any subject, educators must be aware of individual learning styles. The computer is one tool that can be used to facilitate the learning of science. It should be used to extend and enrich the learning experiences available to students.

The following list includes samples of materials from MECC (Minnesota Educational Computing Consortium). Consult your principal or librarian for availability of computer catalogs or software resources.

The Software Evaluation Checklist can be used as a guideline in purchasing software. Please feel free to add or delete any items from the checklist.

REVIEWERS OF COMPUTER SOFTWARE

EPIE (Educational Products Information Exchange). EPIE Institute,
Box 620, Stony Brook, NY 11790.

MICROSIFT (Microcomputer Software Information for Teachers). Computer
Technology Program, Northwest Regional Educational Laboratory,
300 Southwest Sixth Avenue, Portland, OR 97204.

Minnesota Educational Computing Consortium (MECC). MECC, Instructional
Systems Development, 2520 Broadway Drive, St. Paul, MN 55113.

School Microware: A Directory of Educational Software. Dresden
Associates, P.O. Box 246, Dresden, ME 04342.

ADDITIONAL GUIDES FOR EVALUATING SOFTWARE

AEDS MONITOR 20 (April, May, June, 1982).

Microcomputer Software for Instructional Use: Where are the Critical
Reviews?" by Ann Lathrop, The Computing Teacher 9 (February,
1982): 22-26.

National Council of Teachers of Mathematics (NCTM). NCTM,
1906 Association Drive, Reston, VA 22091. \$3.75

SOFTWARE EVALUATION CHECKLIST

PROGRAM NAME: _____ SOURCE: _____
COST: _____ SUBJECT AREA: _____
REVIEWER'S NAME: _____ DATE: _____

1. Instructional Range

_____ grade level(s)
_____ ability level(s)

2. Instructional Grouping for Program Use

_____ individual
_____ small group (size: _____)
_____ large group (size: _____)

3. Execution Time

_____ minutes (estimated) for average use

4. Program Use(s)

_____ drill or practice	_____ problem solving
_____ tutorial	_____ informational
_____ simulation	_____ current and correct information
_____ instructional gaming	_____ other (_____)

5. User Orientation: Instructors Point of View

low	high
.	flexibility
.	freedom from need to intervene or assist

6. User Orientation: Student's Point of View

low	high
.	quality of directions (clarity)
.	quality of output (content an tone)
.	quality of screen formatting
.	freedom from need for external information
.	freedom from disruption by system errors
.	simplicity of user input

7. Recommended Purchase Yes _____ No _____

8. Comments (Optional) _____

RESOURCES

SUGGESTED PERIODICALS

National Geographic World, National Geographic Society, 17th and M Streets Northwest, Washington, DC 20036. (teacher list)

Popular Science, Boulder, CO 80302. (teacher list)

Science World, Scholastic, Inc., 730 Broadway, New York, NY 10003-9538. (teacher list)

Art to Zoo (new), Smithsonian Institution, Office of Elementary and Secondary Education, Washington, DC 20560. (teacher list)

Ranger Rick, National Wildlife Federation, 1412 - 16th Street Northwest, Washington, DC 20036. (children's list)

Smithsonian Journeys, Office of Elementary and Secondary Education, Arts and Industries Building 1163, Washington, DC 20560. (teacher list)

Critter Talk, Merrill Publishing Company, 1300 Alum Creek Drive, Box 508, Columbus, OH, 43216. (children's list)

Science Teacher, 1742 Connecticut Avenue Northwest, Washington, DC 20009. (teacher list)

Science Weekly, P.O. Box 70154, Washington, DC 20088-0154. (children's list)

Sky and Telescope, Sky Publishers Corporation, 49 Bay State Road, Cambridge, MA 02238-1290. (teacher list)

Your Big Backyard, National Wildlife Federation, 1412 - 16th Street Northwest, Washington, DC 20036. (children's list)

PERIODICALS FOR CHILDREN

Current Science, Field Publications, 4343 Equity Drive, Columbus, OH 43228, (Grades 3-6).

North Dakota Outdoors, State Game and Fish Department, 100 North Bismarck Expressway, Bismarck, ND 58501-5095, (Grades 3-6).

Owl, The Canadian Outdoor and Wildlife Magazine for Children, The Young Naturalist Foundation, 59 Front Street East, Toronto, Ontario M5E 1B3, (Grades 3-6).

Ranger Rick's Nature Magazine, National Wildlife Federation, Inc., 1412 - 16th Street Northwest, Washington, DC 20036, (Grades 3-6).

Scienceland, Scienceland, Inc., 501 Fifth Avenue, New York, NY 10017-6165, (Grades K-3).

Science Weekly, P.O. Box 70154, Washington, DC 20088-0154.

Wonder Science, American Chemical Society, 1155 - 16th Street Northwest, Washington, DC 20036, (Grades 3-6).

Your Big Backyard, National Wildlife Federation, Inc., 1412 - 16th Street Northwest, Washington, DC 20036, (Grades K-3).

GENERAL PERIODICALS FOR TEACHERS

Art to Zoo (new), Smithsonian Institution, Office of Elementary and Secondary Education, Arts and Industries Building 1163, Washington, DC 20560.

Council for Elementary Science International News, CESI Membership Chairman, Dr. Betty Burchett, 107A Education Building, University of Missouri, Columbus, MO 65211.

Discover, the News Magazine of Science, Time, Inc., 3435 Wilshire Boulevard, Los Angeles, CA 90010.

Games, Games Publications, Inc., 515 Madison Avenue, New York, NY 10022.

Horizons, The Greater North Dakota Association, 808 Third Avenue South, Fargo, ND 58108.

Journal of Research in Science Teaching, National Association for Research in Science Teaching, John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10016.

Journal of Environmental Education, Heldref Publications, 4000 Albemarle Street Northwest, Washington, DC 20016.

Learning 87, P.O. Box 2580, Boulder, CO 80399.

National Geographic World, National Geographic Society, 17th and M Streets Northwest, Washington, DC 20036.

Natural History, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024.

North Dakota Outdoors, North Dakota Game and Fish Department, 100 North Bismarck Expressway, Bismarck, ND 58501.

Science, American Association for the Advancement of Science, 1515 Massachusetts Avenue Northwest, Washington, DC 20005.

Science and Children, National Science Teachers Association, 1742 Connecticut Avenue Northwest, Washington, DC 20009.

Science World, Scholastic, Inc., 902 Sylvan Avenue, Englewood Cliffs, NJ 06732.

Scientific American, Subscription Department, 415 Madison Avenue, New York, NY 10017.

Sky and Telescope, Sky Publishers Corporation, 49 Bay State Road, Cambridge, MA 02238-1290.

Smithsonian, Smithsonian Institution, Membership Data Center,
P.O. Box 2953, Boulder, CO 80321.

The Prairie Naturalist, University of North Dakota, University Station,
Box 8238, Grand Forks, ND 58202.

Tops Ideas, Tops Learning Systems, 10978 South Mulino Road, Canby, OR
97013.

SUPPLY SOURCES - CATALOGS

Burt's Whole Catalog, P.O. Box 732, Weston, MA 02193-0732, 617-647-0674.

Catalog for Industry and Education, Edmund Scientific, 101 East Gloucester Pike, Barrington, NJ 08007, 609-547-3488.

Creative Publications, 5005 West 110th Street, Oak Lawn, IL 60453, 800-624-0822.

Discovery Toys, 400 Ellenwood Way, Suite 300, Pleasant Hill, CA 94523, 701-225-6279.

Earth Science and Life Science, Hubbard, P.O. Box 104, Northbrook, IL 60065.

Elementary Science, Frey Scientific, 905 Hickory Lane, Mansfield, OH 44905, 800-225-FREY.

Elementary Science and Math Materials, Carolina, 2700 York Road, Burlington, NC 27215, 800-334-5551.

EME Science, Educational Materials and Equipment Company, P.O. Box 17, Pelham, NY 10803, 914-576-1121.

ESS Elementary Science Study, Delta Education, Box M, Nashua, NH 03061, 800-258-1302.

Geology/Earth Science, Wards, 5100 West Henrietta Road, P.O. Box 92912, Rochester, NY 14692-9072, 800-962-2660.

Quality Experiences in Science and Technology K-9, Cuisenaire Company of America, Inc., 12 Church Street, Box D, New Rochelle, NY 10802, 800-237-3142.

Safety Equipment and Supplies for Today's Technologies: 1988 General Catalog, P.O. Box 1368, Janesville, WI 53547-1368, 800-356-0783.

Science Catalog, Delta Education, P.O. Box M, Nashua, NH 03061-6012, 800-258-1302.

Science '88: The Key to Successful Teaching, Nasco, 901 Janesville Avenue, Fort Atkinson, WI 53538, 414-563-2446.

Sourcebook for Science Material, Opportunity for Learning, Inc., 20417 Nordhoff's Street, Department X89, Chatsworth, CA 91311.

The Lab Mart, (laboratory apparatus), J. H. Berge, 4111 South Clinton Avenue, South Plainfield, NJ 07080, DC: 202-682-3994, NY: 212-925-5197, NJ: 201-561-1234.

TOPS Ideas, 10978 South Mulino Road, Canby, OR 97013.

RESOURCES FOR REGIONAL EARTH SCIENCE

- Brown, F. M., and Bailey, W. (1978). Earth Science. Chicago: Scott-Foresman and Company.
- Cvancara, A. M. (1985). A Field Manual for the Amateur Geologist: Tools and Activities for Exploring Our Planet. Engelwood Cliffs, NJ: Prentice-Hall, Inc.
- Kaufman, W. J. (1978). Exploration of the Solar System. New York: Macmillan Publishing Company.
- Kohland, W. F. (1977). Guide to Mineral Identification: A Laboratory and Field Manual. California, PA: Allegheny Press.
- Levin, H. L. (1978). The Earth Through Time. Philadelphia: W. B. Saunders Company.
- Sawkins, F. S., et al. (1978). The Evolving Earth. New York: Macmillan Publishing Company.

RESOURCES FOR REGIONAL PLANTS

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American Trees. New York: Golden Press.

NORTH DAKOTA PLANT PUBLICATIONS

List of Publications for Farm, Home, and Community

This list can be obtained from your Local County Extension Service usually located in the Court House. The list is also available from:

Agricultural Communication Bulletin Room
North Dakota State University
Morrill Hall
Fargo, ND 58105

North Dakota residents may get single copies of up to ten different publications free. They include publications on collecting, pressing, mounting, and storing plants, caring for indoor plants, and many other helpful bulletins.

State Forest Service
North Dakota State University
Cooperative Extension Service
Fargo, ND 58105

NORTH DAKOTA EARTH SCIENCE GUIDES

List of Educational Series available from North Dakota Geological Survey, University Station, Grand Forks, North Dakota 58202-8156.

Guide to the Geology of Northeastern North Dakota by Mary E. Bluemle.

This guidebook, written for the layman, explains the geology of northeastern North Dakota including Cavalier, Grand Forks, Nelson, Pembina, and Walsh Counties. The guidebook includes four roadlogs and a geologic map in color (scale about 1/8 inch to the mile), 33 pages, 1972; 31 pages, Revised 1975. Free

Guide to the Geology of Southeastern North Dakota by John P. Bluemle.

This guidebook, written for the layman, explains the geology of southeastern North Dakota including Barnes, Cass, Griggs, Ransom, Richland, Sargent, Steele, and Traill Counties. The guidebook includes four roadlogs and a geologic map in color (scale about 1/8 inch to the mile), 37 pages, 1972; 33 pages, Revised 1975. Free

Guide to the Geology of South-Central North Dakota by John P. Bluemle.

This guidebook, written for the layman, explains the geology of south-central North Dakota including Burleigh, Dickey, Emmons, Kidder, LaMoure, Logan, McIntosh, and Stutsman Counties. The guidebook includes 11 roadlogs and a colored geologic map (scale about 1/8 inch to the mile), 45 pages, plate 1, 1973. Free

Guide to the Geology of North-Central North Dakota by John P. Bluemle.

This guidebook, written for the layman, explains the geology of north-central North Dakota including Benson, Bottineau, Eddy, Foster, McHenry, Pierce, Ramsey, Rolette, Sheridan, Towner, and Wells Counties. The guidebook includes eight roadlogs and a geologic map in color (scale about 1/8 inch to the mile), 41 pages, plate 1, 1974. Free

Guide to the Geology of Northwest North Dakota by John P. Bluemle.

This guidebook, written for the layman, explains the geology of northwest North Dakota including Burke, Divide, McLean, Mountrail, Renville, Ward, and Williams Counties. The guidebook includes eight roadlogs and a geologic map in color (scale about 1/8 inch to the mile), 38 pages, plate 1, 1975. Revised edition 1981. Free

Guide to the Geology of Southwest North Dakota by John P. Bluemle.

This guidebook, written for the layman, explains the geology of southwest North Dakota including Adams, Billings, Bowman, Dunn, Golden Valley, Grant, Hettinger, McKenzie, Mercer, Morton, Oliver, Sioux, Slope, and Stark Counties. The guidebook includes seven roadlogs and a geologic map in color (scale about 1/8 inch to the mile), 37 pages, plate 1, 1975. Revised edition 1981. Free

The Prairie: Land and Life by John P. Bluemle. This guidebook prepared in cooperation with the U.S. Forest Service describes the natural environment of North Dakota's prairie, 12 pages, 1975. \$.50

The Face of North Dakota--The Geologic Story by John P. Bluemle. A nontechnical description of the geology of North Dakota heavily illustrated with photos, diagrams, and maps. The publication includes a full-color geologic highway map of the state to be used in conjunction with the text or as a separate reference while traveling around North Dakota, 75 pages, 1977. \$1.00

Petroleum--A Primer for North Dakota by Erling A. Brostuen. A nontechnical discussion of the origin, exploration for, and production of crude oil and natural gas in North Dakota. It includes a discussion of the regulation of the petroleum exploration and producing industry in North Dakota, 34 pages, 1981. Free

Geologic Time in North Dakota by John P. Bluemle and Lee Clayton. This is a nontechnical discussion of geologic time and what it means to North Dakota. The publication uses a series of diagrams to illustrate the geologic events that have occurred in North Dakota, 17 pages, 1982. Free

Geology Along North Dakota Interstate 94, compiled by John P. Bluemle. This publication consists of a map and roadlog pointing out important geologic features along I-94. The roadlog coincides with mileage markers along the highway. The brochure also includes background information on North Dakota geology, 1983. Free

MAPS FOR EARTH SCIENCE

Topographic maps can be obtained for your area by requesting the index for North Dakota. Write to:

Western Distribution Branch
U.S. Geological Survey
Federal Center, Box 25286
Denver, CO 80225

Aerial photographs of your area can be obtained by writing to:

U.S. Geological Survey
507 National Center
Reston, VA 22092
703-860-6045

or

User Service Section
EROS Data Center
U.S. Geological Survey
Sioux Falls, SD 57198
605-594-6511

SCIENCE IN THE KITCHEN

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BOOKS FOR SCIENCE EXPERIMENTS

- Allison, L. (1975). The Reasons for Seasons (The Great Cosmic Megagalectic trip without moving from your chair). Boston, MA: Little, Brown and Company.
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MISCELLANEOUS RESOURCES

American Association for the Advancement of Science, 133 H Street
Northwest, Washington, DC 20005.

Coaches Manual and Rules, Science Olympiad, 5955 Little Pine Lane,
Rochester, MI 48064.

Department of Agriculture, Capitol Building, Bismarck, ND 58505.

Educators Guide to Free Films, Educators Progress Service, Inc.,
214 Center Street, Randolph, WI 53956.

Johnson Space Center, AP4-Teacher Resource Center, Houston, TX 77058.

Kui Talk, Newsletter of the Native American, Science Education
Association, 1228 M Street Northwest, Washington, DC 20005, 202-638-7066.

Local Power Company

National Science Teachers Association, 1742 Connecticut Avenue Northwest,
Washington, DC 20009.

North Dakota Dairy Council, 423 North State Street, Bismarck, ND 58501.

North Dakota Department of Public Instruction, Supply Division, Capitol
Building, Bismarck, ND 58505-0440.

North Dakota Lignite Council, Norwest Bank, Suite 410, Box 2277,
Bismarck, ND 58502.

North Dakota Science Teachers Association, NDEA, Bismarck, ND 58501.

North Dakota State Water Commission, 900 East Boulevard, WET (K-3), Water
Education for Teachers, Bismarck, ND 58505, 701-224-2750.

Public Broadcasting System Service, 475 L'Enfant Plaza W Southwest,
Washington, DC 20024.

Shell Oil, P.O. Box 2463, Houston, TX 77001.

State Film Library, North Dakota State University, University Station,
Fargo, ND 58105.

State Forest Service, Extension Forester, Cooperative Extension Service,
North Dakota State University, Fargo, ND 58105.

State Game and Fish Department, 100 North Bismarck Expressway, "Project
Wild," Bismarck, ND 58501.